# THE IMPACT OF THE DIGITAL TRANSFORMATION ON THE GEOGRAPHY OF INNOVATION

Caroline Paunov

Head of Secretariat of the OECD-TIP Working Party

27 September 2018



OECD
BETTER POLICIES FOR BETTER LIVES

# Structure

1. What are the impacts of digital transformation on innovation?
2. Why does it matter for the geography of innovation?
3. Evidence on co-location of research & industry
4. Policy implications

# Main issues

1. Marginal cost of producing and scaling up **intangible products** changes innovation in the digital age
   i. more collaborative ii. faster
   iii. more service-based iv. with data as core input
2. **Market dynamics are affected** at social, industrial and *regional level*
3. **Distance is not "dead" -> the world is "spiky"**
4. Support for regions needs to take into account these dynamics & new ways of connecting -> **research institutions are pivotal**

# Structure

1. What are the impacts of digital transformation on innovation?
2. Why does it matter for the geography of innovation?
3. Evidence on co-location of research & industry
4. Policy implications

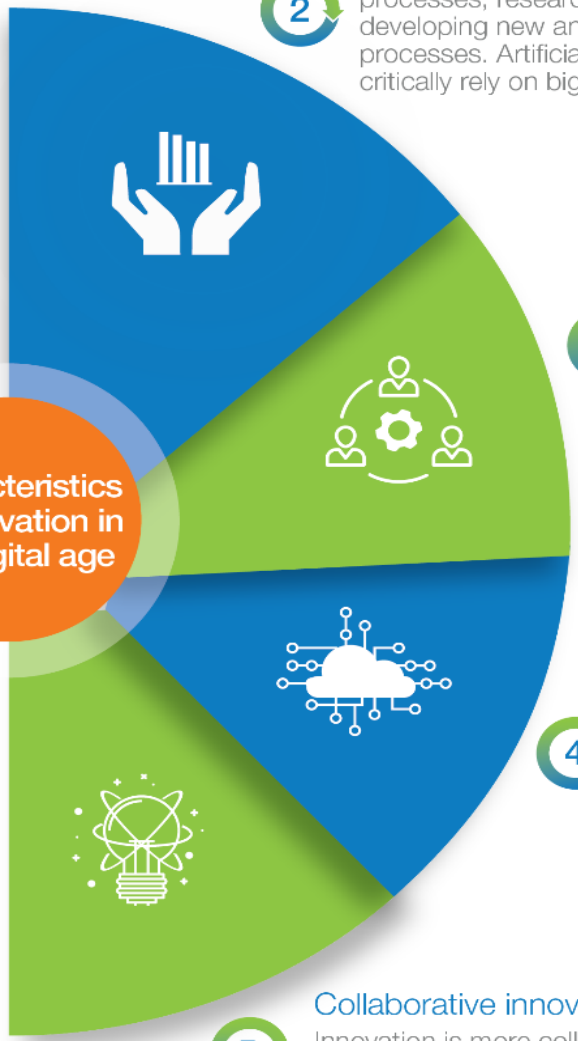
# 1. WHAT IS THE IMPACT OF THE DIGITAL TRANSFORMATION ON INNOVATION?

# Digital is everywhere

**Most innovations today** (in products, processes and business models) **are at least partially digital** (i.e. enabled by digital tools or embodied in data & software)…

Digital technologies lower the marginal cost of producing and scaling up **intangible products** (fluidity)

# Key **characteristics of innovation** in the digital age




### 1 Lower production costs and fluidity of innovative products

Digital technologies drastically lower the marginal costs of producing and scaling up intangible products ('fluidity'). Effects spread to the entire economy as tangible products increasingly embody intangible components, transforming them into smart and connected products ('Internet of Things').

### 2 Data as core input

Data from a variety of sources (e.g. consumer behaviour, business processes, research) are a key input for innovation – they enable developing new and highly customised products, and optimising processes. Artificial intelligence (AI) and machine learning tools critically rely on big data.

### 3 Servitisation

Digital technologies offer opportunities for innovative services. They lead to a blurring of the boundaries between manufacturing and services innovation as manufacturers develop services to complement their products while service providers enter manufacturing.

### 4 Faster innovation cycles

Digital technologies accelerate innovation cycles. Virtual simulation and 3D printing speed up design, prototyping and testing, reducing costs and time-to-market. Direct releases of product upgrades on easily accessible online markets have also become more frequent.

### 5 Collaborative innovation

Innovation is more collaborative as innovation requires mixing skills, expertise and technologies. New tools for open innovation (e.g. industry platforms) facilitate such collaborations.

Source: Guellec and Paunov (2018), Innovation in the Digital Age, OECD Science, Technology and Innovation Outlook, forthcoming

# Structure

1. What are the impacts of digital transformation on innovation?
2. Why does it matter for the geography of innovation?
3. Evidence on co-location of research & industry
4. Policy implications


2. WHY DOES IT MATTER FOR THE GEOGRAPHY OF INNOVATION?

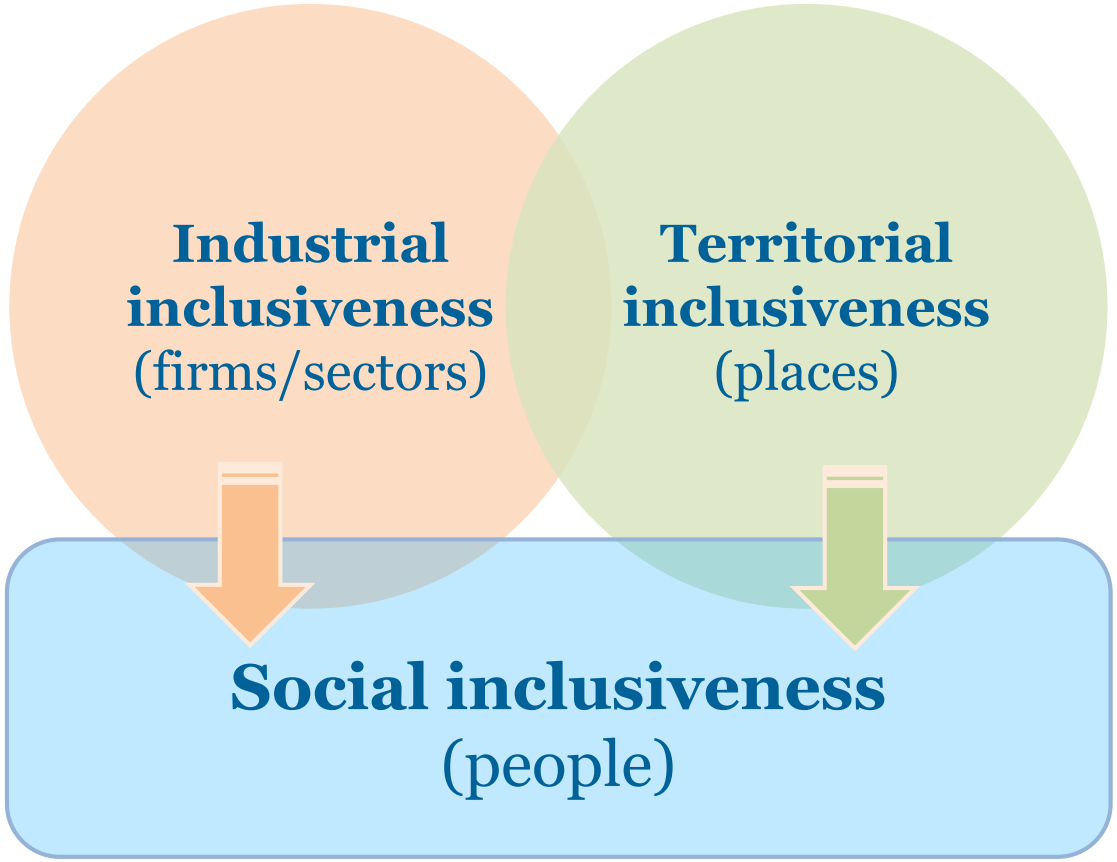
## **Market dynamics** are changing

*Non-rivalry* of knowledge makes the market production different from the tangible goods

⇒ knowledge production is subject to massive economies of scale: the more products sold, the lower the average cost

**Distributional questions**

# Industrial, territorial and social inclusiveness



# Industrial, territorial and social inclusiveness

## Firms/sectors

Rising differential in market performance

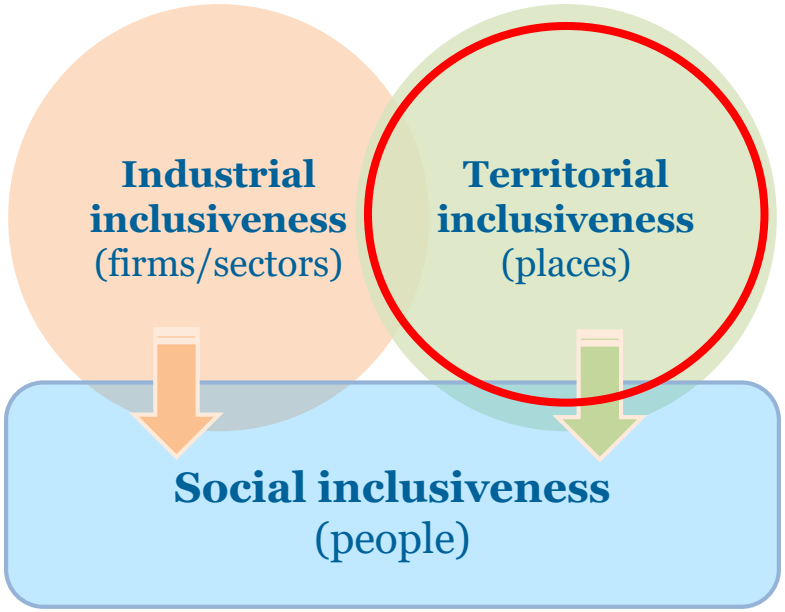
## People

Rising income & welfare differentials

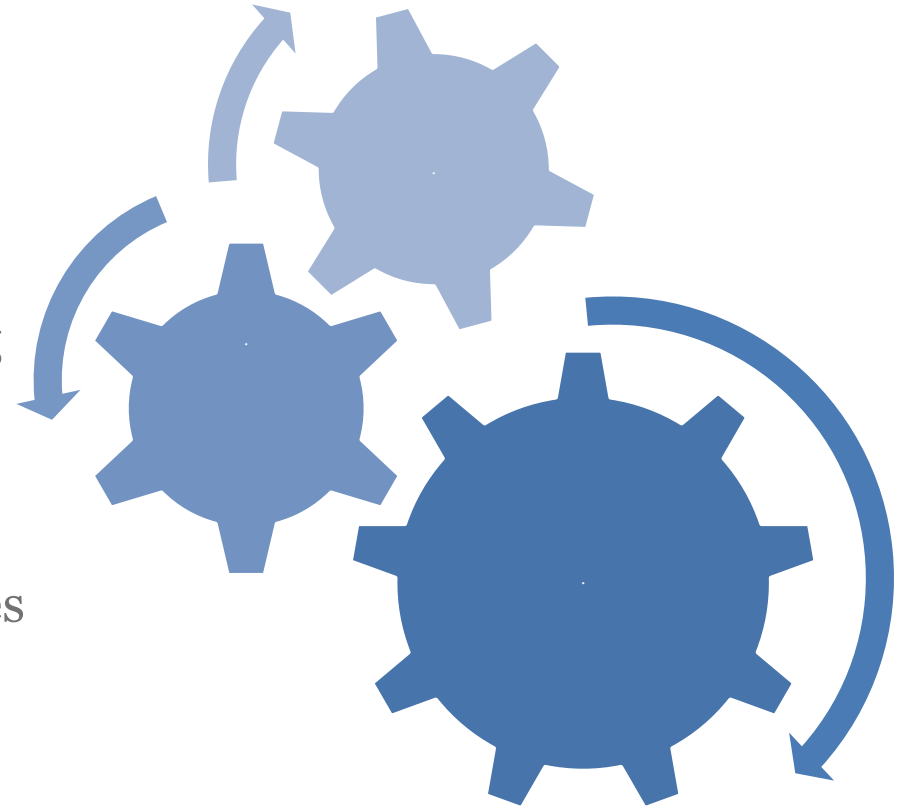
## Places

Rising differential between cities, urban & rural areas

→ the world is spiky



# **Interactions** between the three dimensions



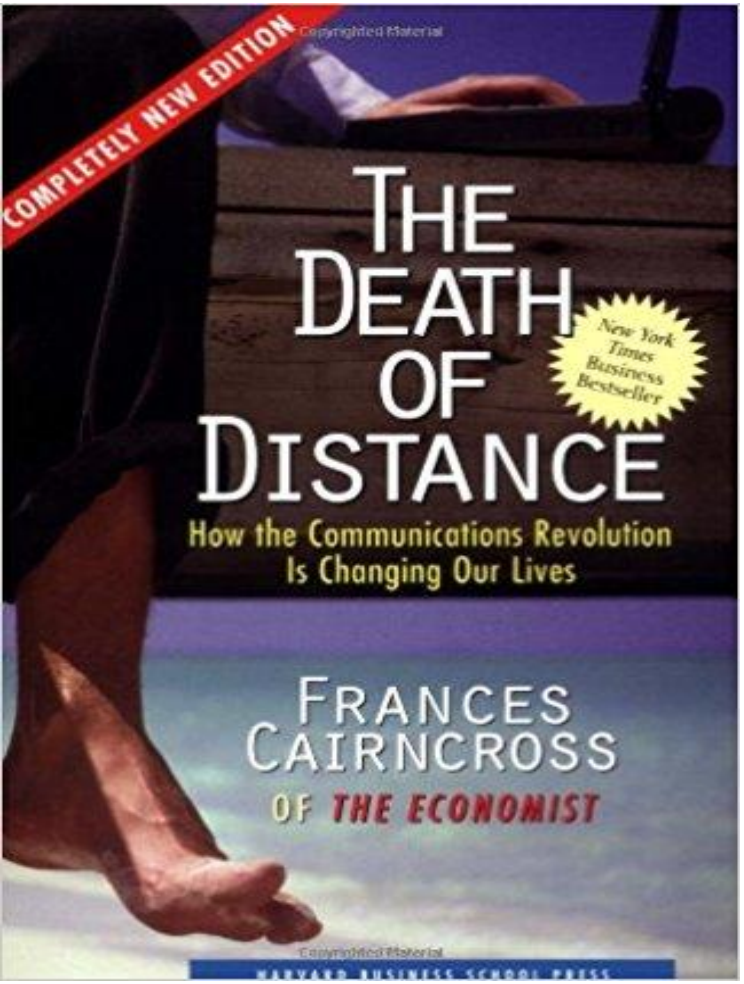
## Business concentration

- Increased **income inequality** (redistribution of market rents among stakeholders of the benefitting companies)
- Increased **geographical inequality** (current competition between US cities to attract Amazon 2nd headquarters)

## Individuals' income concentration

- Increased **geographical inequality** (large cities vs. the country side)

# The **geographical concentration** of innovation




- Zero communication cost promised the **« death of distance »** - innovation could take place everywhere…
- … **The opposite has happened** over the past decade: large cities are leading innovation - location is more relevant than ever.
- Location matters because **interpersonal contact** (which requires physical proximity) is key to knowledge sharing
- The **fluidity of data** allows it to go wherever it is best used… it goes to large cities

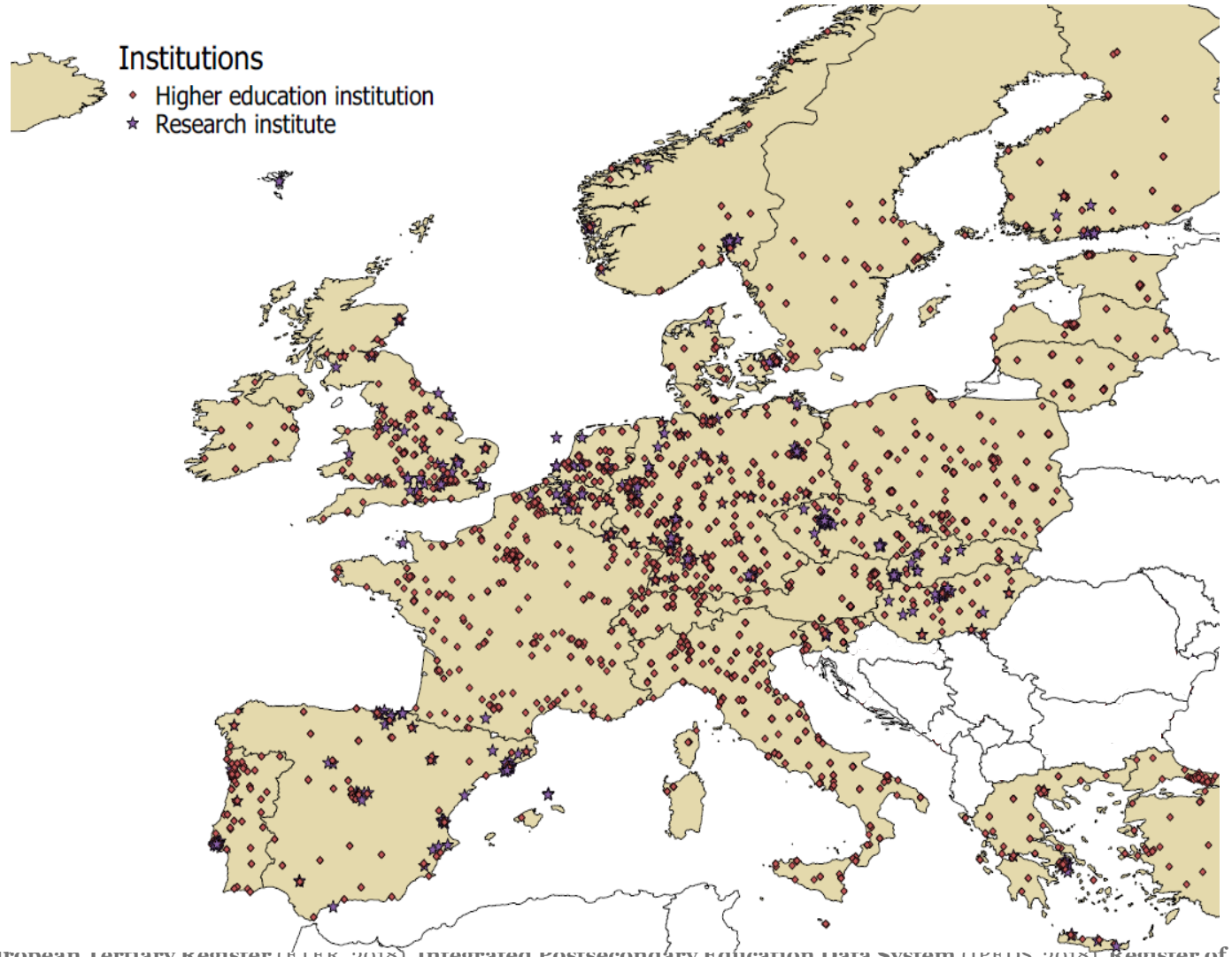
# Structure

1. What are the impacts of digital transformation on innovation?
2. Why does it matter for the geography of innovation?
3. Evidence on co-location of research & industry
4. Policy implications

# 3. EVIDENCE ON CO-LOCATION OF RESEARCH AND INDUSTRY

# Location of research institutions

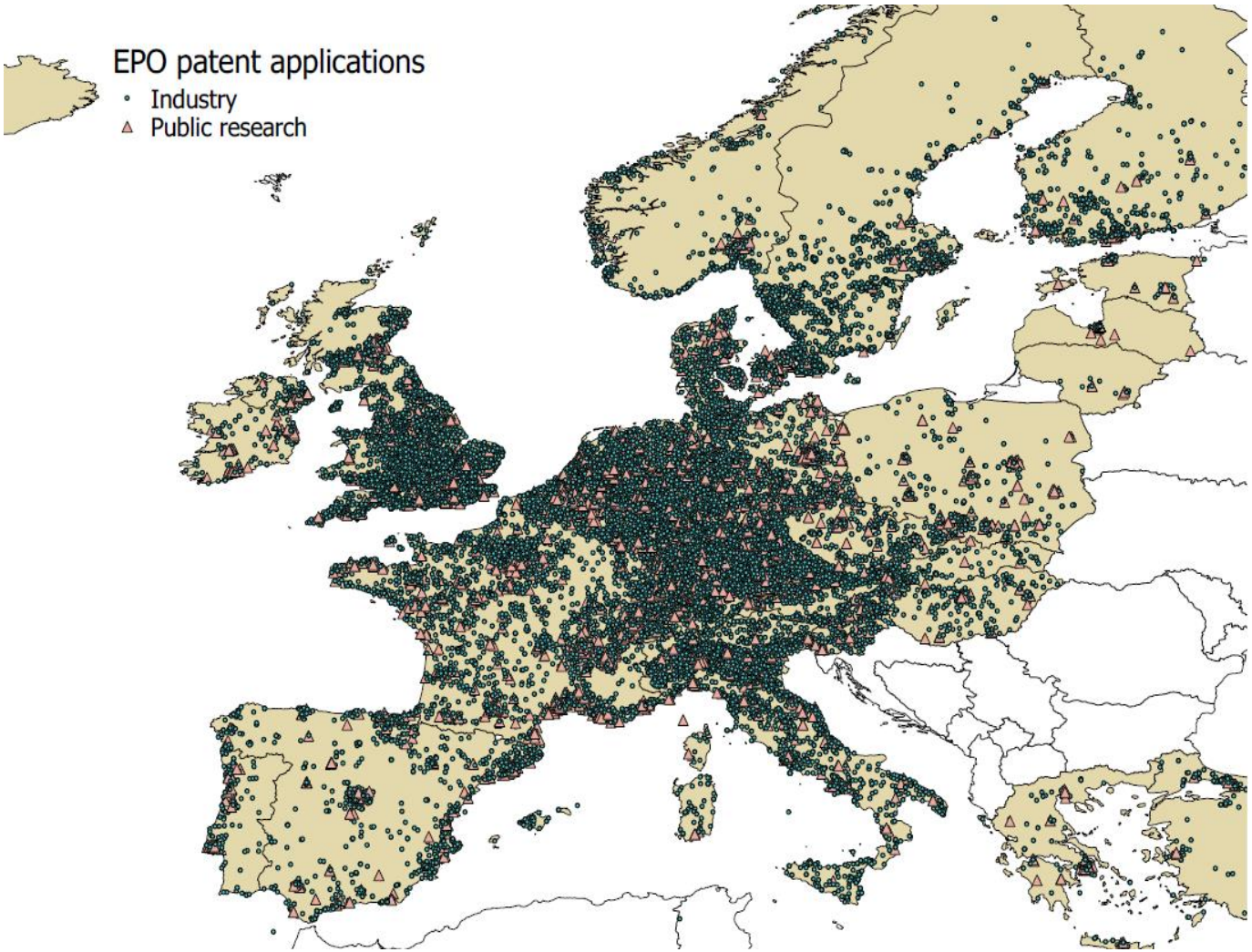
Europe, 1993-2013




*Source:* **European Tertiary Register** (ETER, 2018), **Integrated Postsecondary Education Data System** (IPEDS, 2018), **Register of Public-Sector Organizations** (ORGREG, 2018) and **World Higher Education Database** (WHED, 2018).

# Location of EPO inventors

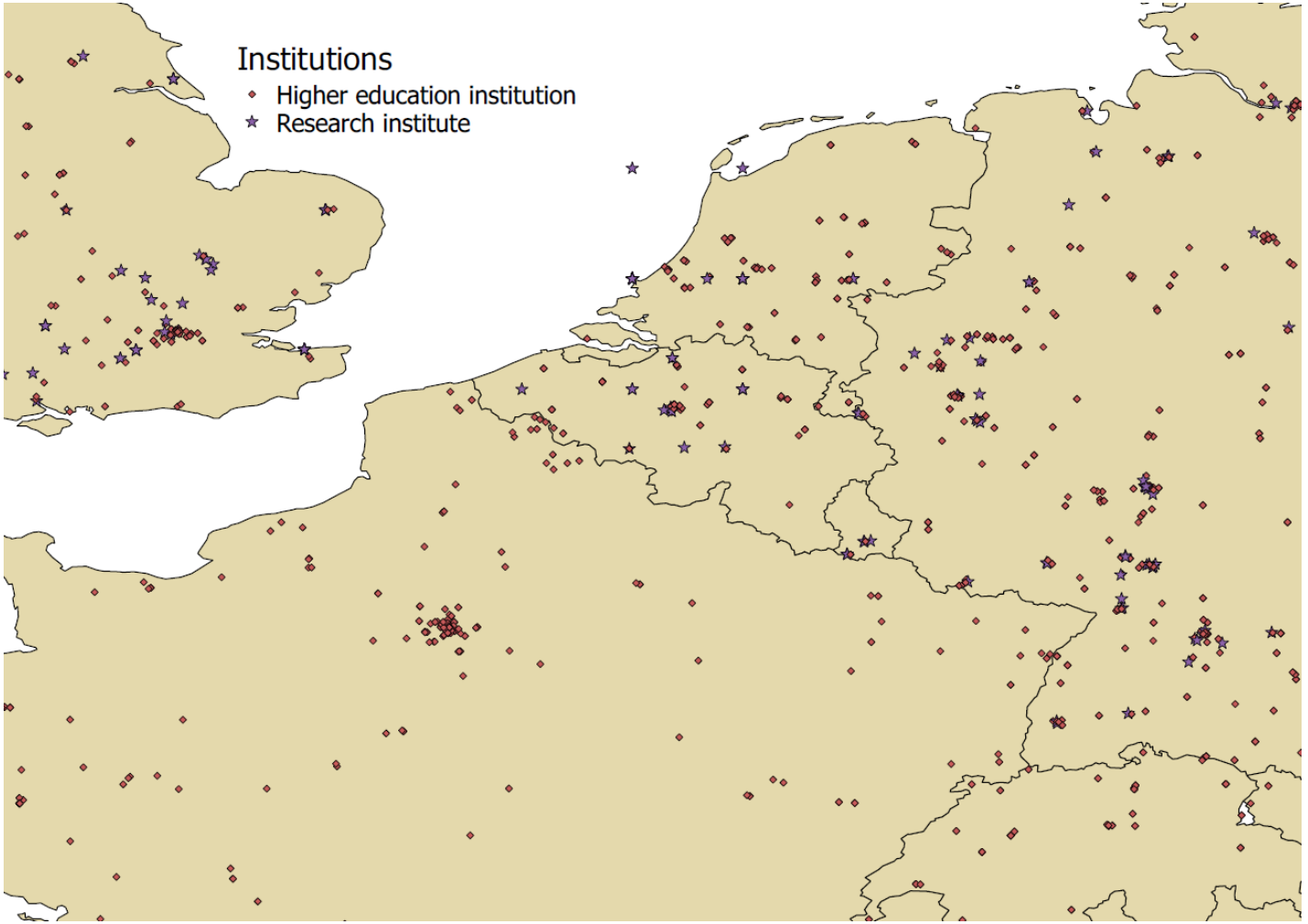
Europe, 1993-2013




*Source:* Information of inventor address is taken from **PATSTAT** (autumn, 2017 version).

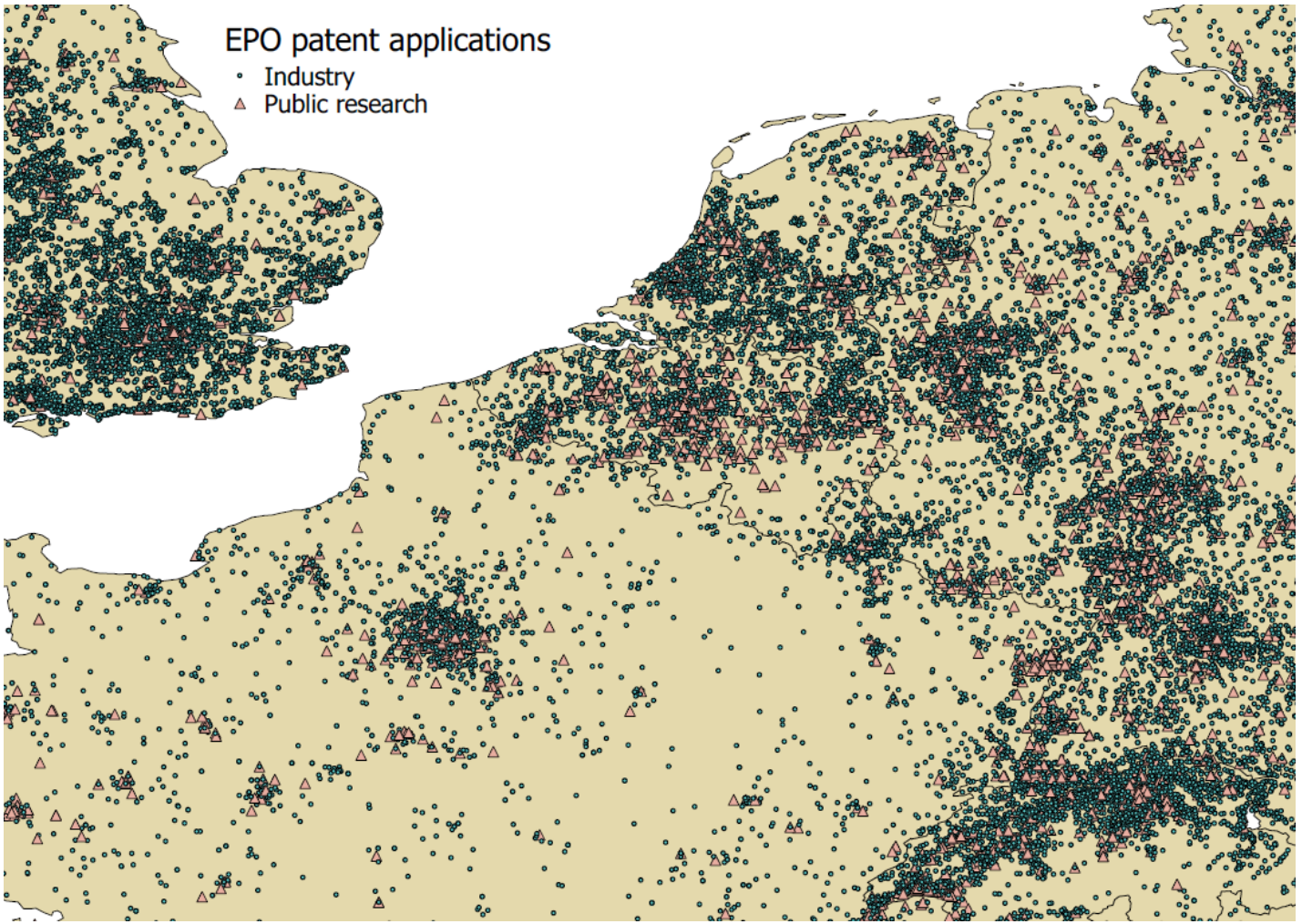
# Location of research institutions

Selected Western European countries, 1993-2013




*Source:* **European Tertiary Register** (ETER, 2018), **Integrated Postsecondary Education Data System** (IPEDS, 2018), **Register of Public-Sector Organizations** (ORGREG, 2018) and **World Higher Education Database** (WHED, 2018).

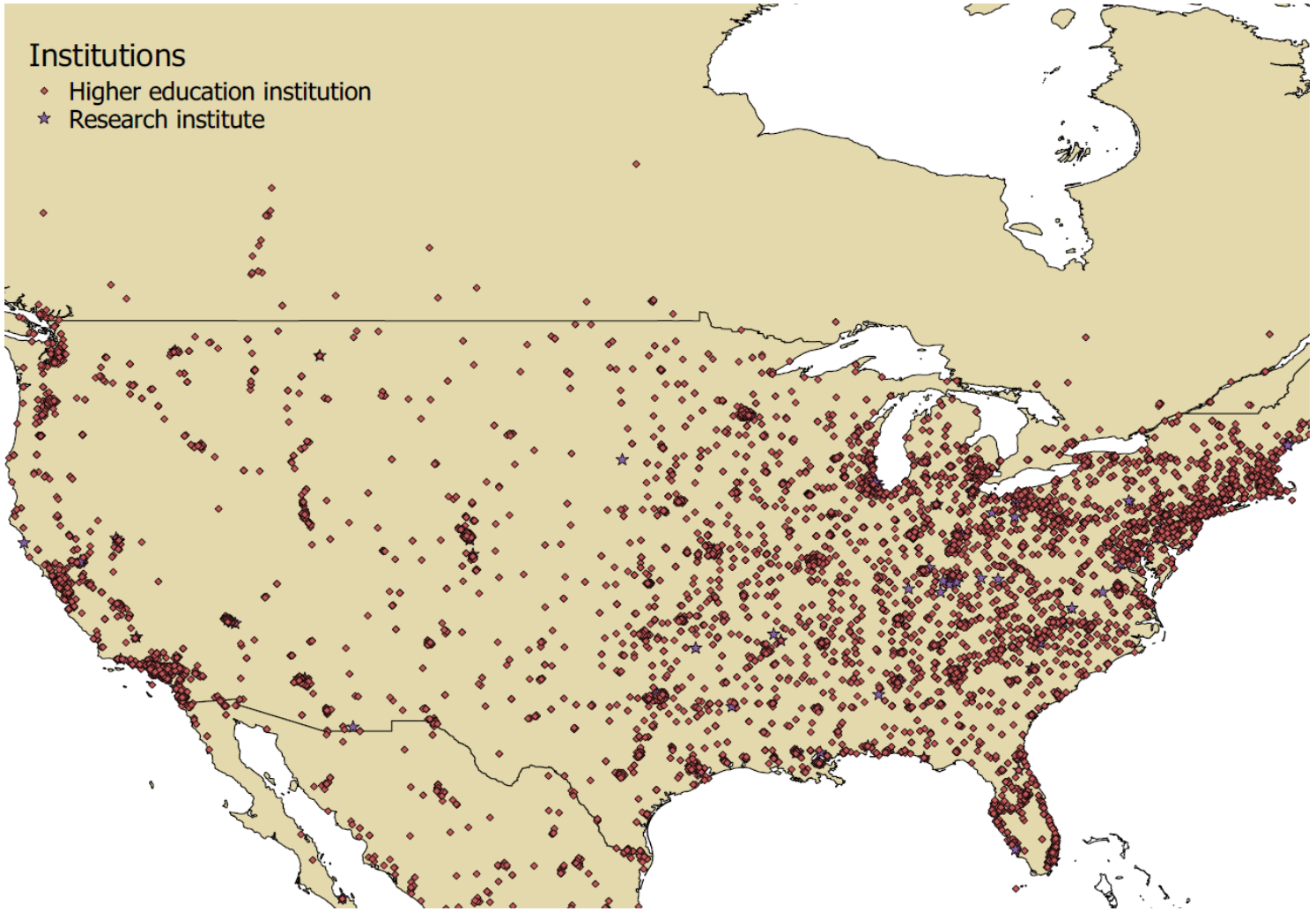
# Location of EPO inventors
# Selected Western European countries, 1993-2013




*Source:* Information of inventor address is taken from **PATSTAT** (autumn, 2017 version).

# Location of research institutions

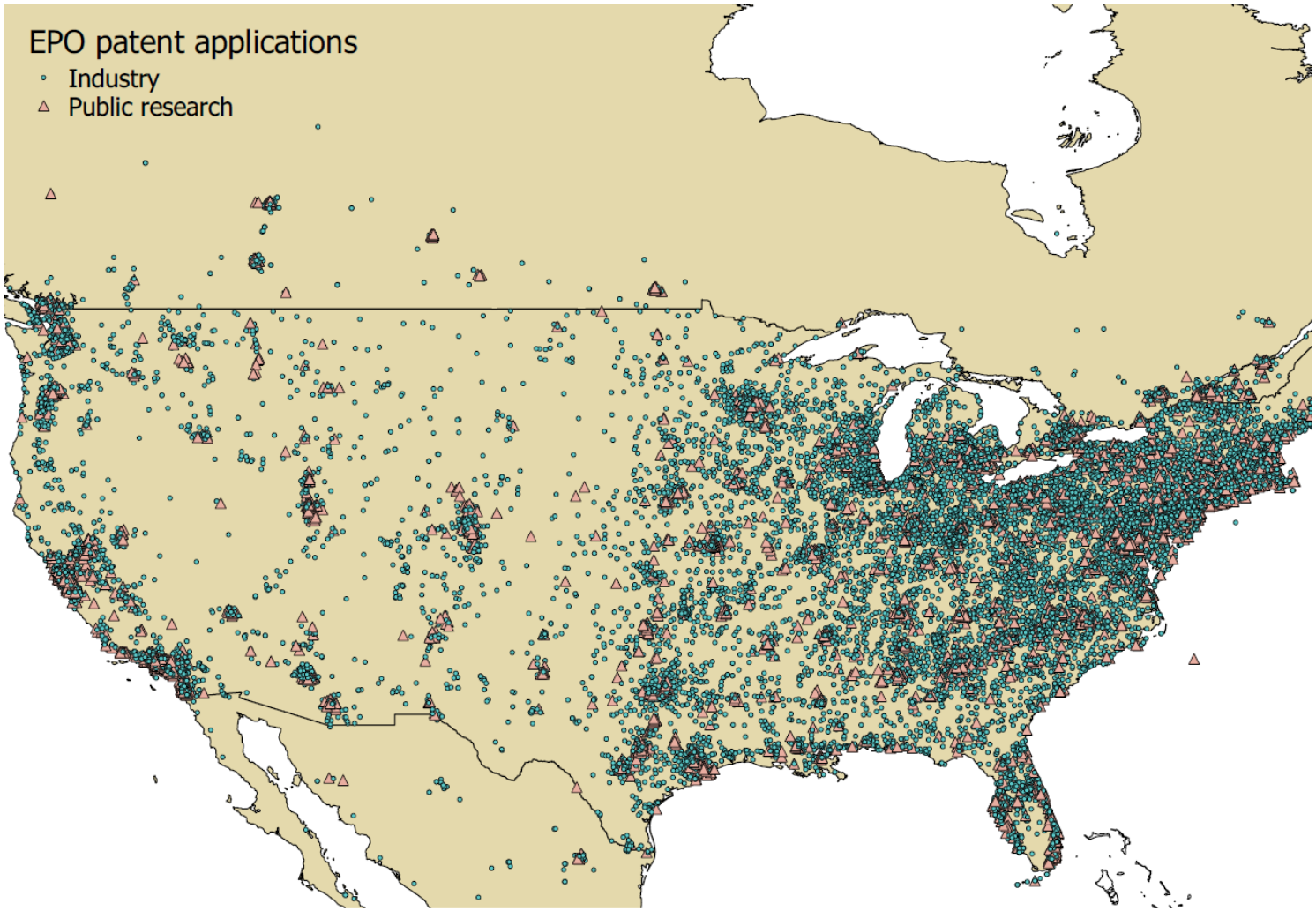
North America, 1993-2013




*Source:* **European Tertiary Register** (ETER, 2018), **Integrated Postsecondary Education Data System** (IPEDS, 2018), **Register of Public-Sector Organizations** (ORGREG, 2018) and **World Higher Education Database** (WHED, 2018).

# Location of EPO inventors

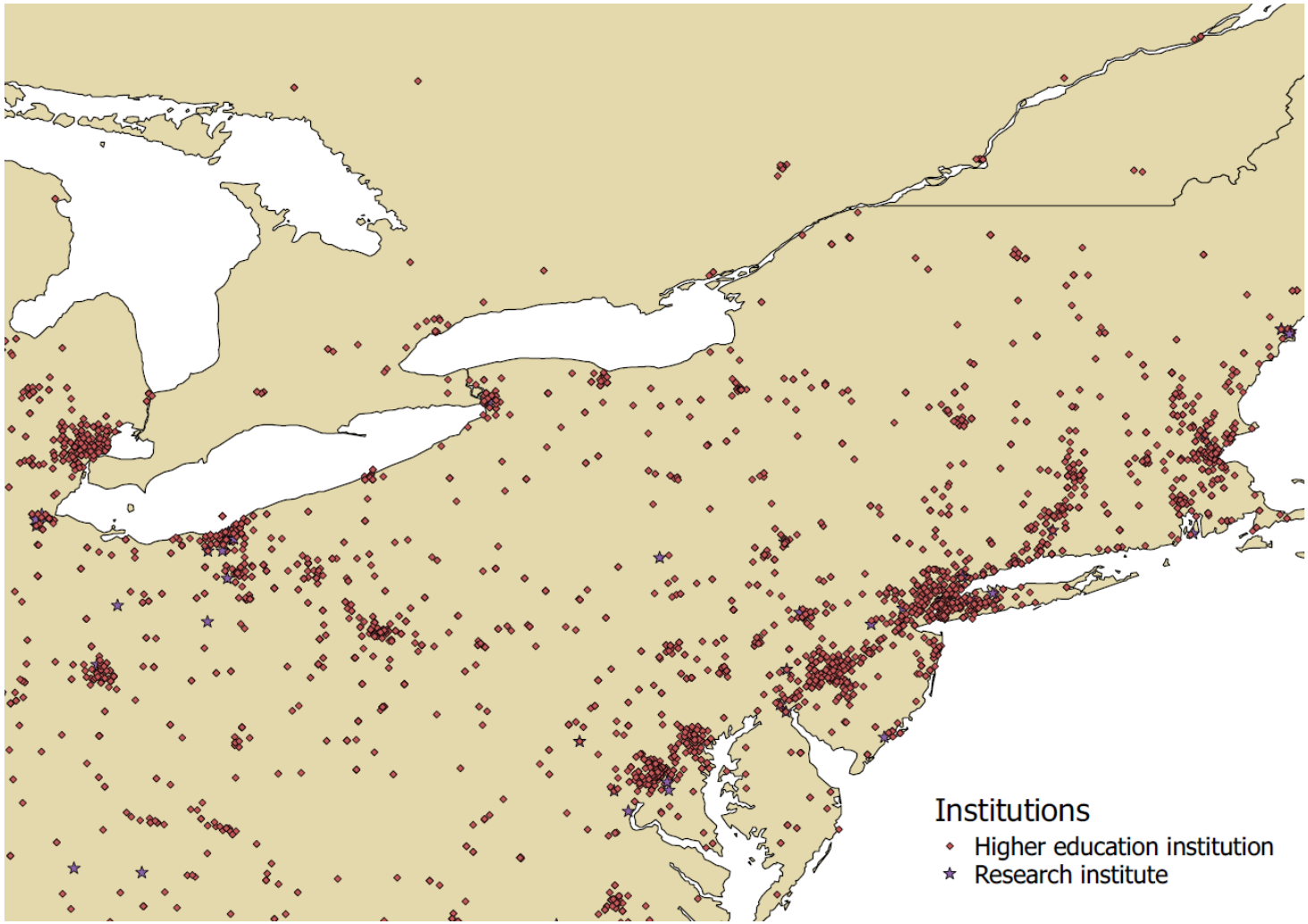
North America, 1993-2013




*Source:* Information of inventor address is taken from **PATSTAT** (autumn, 2017 version).

# Location of research institutions

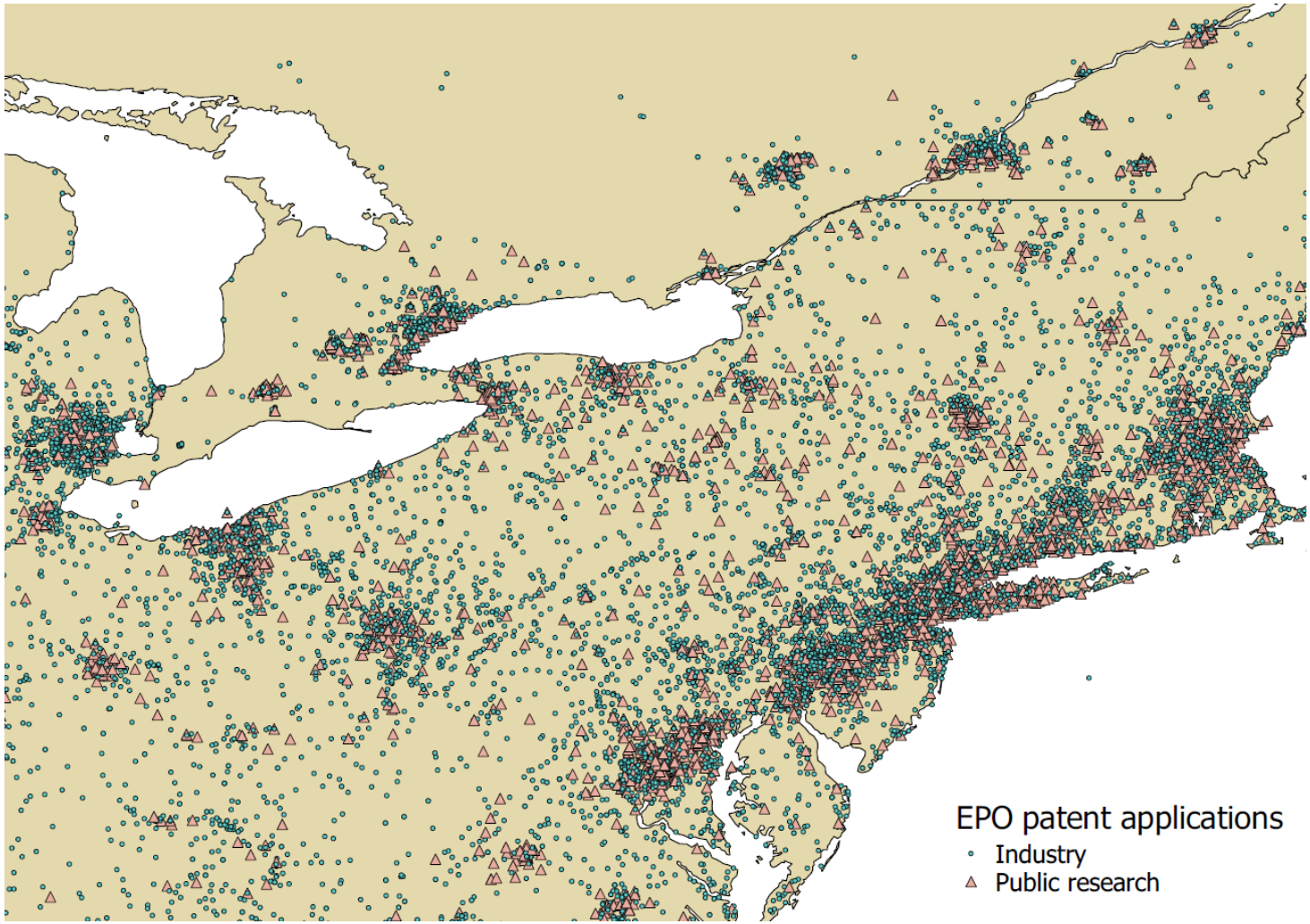
## Canada and United States, 1993-2013




*Source:* **European Tertiary Register** (ETER, 2018), **Integrated Postsecondary Education Data System** (IPEDS, 2014), **Register of Public-Sector Organizations** (ORGREG, 2018) and **World Higher Education Database** (WHED, 2017).

# Location of EPO inventors

## Canada and United States, 1993-2013




*Source:* Information of inventor address is taken from **PATSTAT** (autumn, 2017 version).

# Impact of geographic proximity to universities

## Evidence using proximity to historical mines

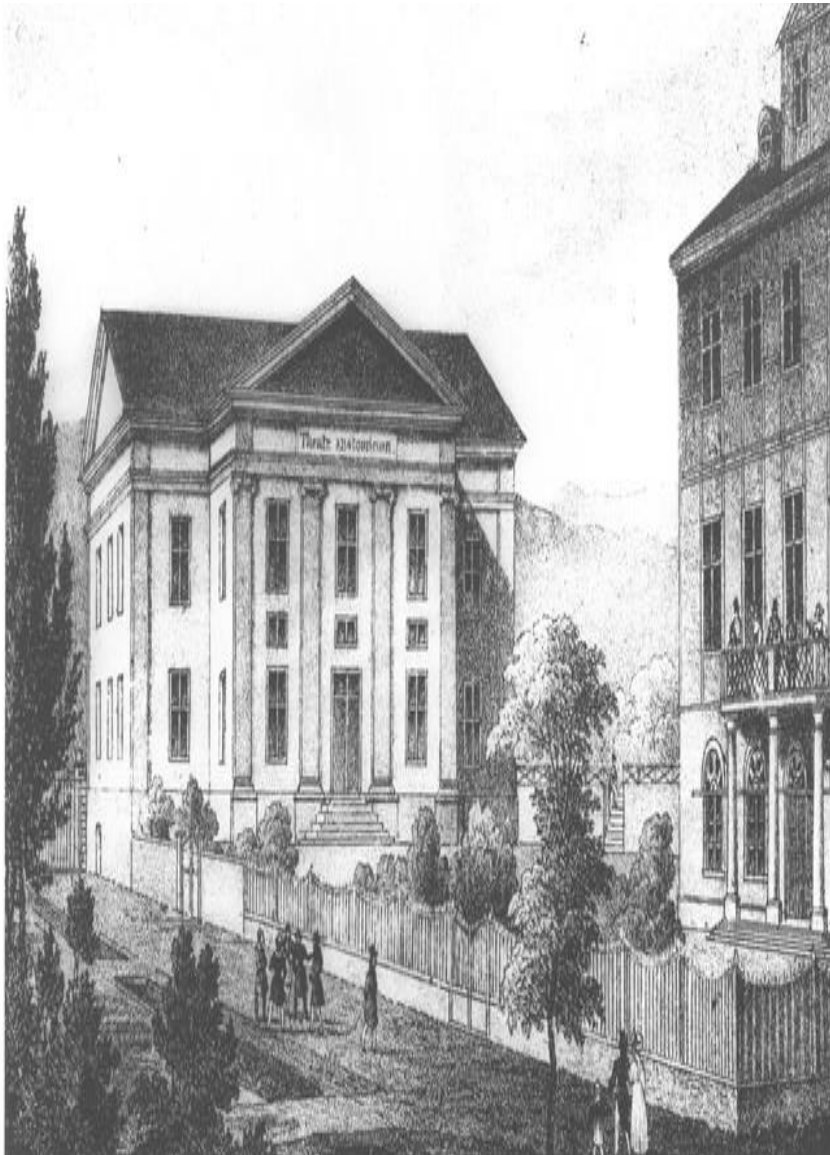
- **Co-location of universities and industry** might be driven by local business dynamics
- To identify **causal effects of proximity to universities**, we use **proximity to historical mines**

$$distance\_university_i = \alpha_1 + distance\_mine_i + u_i \qquad \text{(1st stage)}$$

$$\Delta \ln\_industry\_patenting_i^{1993-2013} = \alpha_2 + distance\_university_i + \varepsilon_i \qquad \text{(2nd stage)}$$

# Why geographical distance to historical mines?

- **Historical mines predict distance to modern universities** because technical universities were established around mines in the 19th century
- Provided **education in engineering and applied sciences** according to **needs of industrial revolution**
- *Less* (but not unrelated !) to modern dynamics of innovation ecosystems



# Sample

## For estimating proximity effects

| Country | Observations | Country | Observations |
|---|---|---|---|
| Australia | 6,755 | Japan | 10,511 |
| Austria | 3,145 | Korea | 4,369 |
| Belgium | 8,649 | Luxembourg | 328 |
| Canada | 43,740 | Latvia | 151 |
| China | 5,714 | Netherlands | 6,199 |
| Czech Republic | 3,198 | Norway | 1,189 |
| Denmark | 1,841 | New Zealand | 1,324 |
| Estonia | 131 | Poland | 580 |
| Finland | 1,006 | Portugal | 267 |
| France | 5,975 | Sweden | 2,762 |
| Germany | 46,889 | Slovenia | 226 |
| Greece | 661 | Slovak Republic | 25 |
| Hungary | 784 | Spain | 3,090 |
| Ireland | 3,681 | Switzerland | 8,480 |
| Israel | 9,088 | Turkey | 730 |
| Iceland | 785 | United Kingdom | 50,171 |
| Italy | 3,963 | United States | 232,058 |
| **TOTAL** | | | **468,465** |

# Proximity to universities matters for industry patenting

## Instrumental variable estimation using geographical proximity to historical mines

| Dependent variable: | Proximity in km to closest university (Instrument) | Growth of industry EPO patent applications over 2012-13 (1 year) | Growth of industry EPO patent applications over 2008-13 (5 year) | Growth of industry EPO patent applications over 2003-13 (10 year) |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Proximity in km to closest pre-1900 mine | **0.100*****<br>(0.005) | | | |
| Proximity in km to closest university | | **0.001****<br>(0.000) | **0.003*****<br>(0.001) | **0.005****<br>(0.002) |
| Observations | 468,465 | 468,465 | 320,862 | 167,314 |

*Note*: *, **, and *** indicate significance at 10%, 5% and 1% levels respectively

Source: Borowiecki and Paunov (forthcoming), Cross-country perspectives on the role of universities

# Structure

1. What are the impacts of digital transformation on innovation?
2. Why does it matter for the geography of innovation?
3. Evidence on co-location of research & industry
4. Policy implications


4. WHAT WAY TO GO
FOR POLICY?

# A number of **priorities for innovation policy** to set


Source: Guellec and Paunov (forthcoming) "Innovation policies in the digital age", in OECD (forthcoming) *STI Outlook 2018*

# Questions for **smart specialisation strategies**

**1.** *In view of dynamics of concentration*, what are **realistic** options available for diversification?

**2.** What are the **desirable** *ways of diversification from a national and trans-national perspective* in the digital age?

**3.** How to *take* **advantage of market drivers** & build more effective tools for regional development?

# Some **food for thought** to answer those questions

- **Proximity still matters** & leads to strong concentration (top cities -> real estate, congestion, …) …
- .. yet new features of **collaboration** undeniably gain in importance: virtual platforms, connections in proximity & across distances and multi-disciplinarity
- **Public research policies** & **knowledge co-creation** options are core in new format: multi-disciplinarity

# Structure

1. What are the impacts of digital transformation on innovation?
2. Why does it matter for the geography of innovation?
3. Evidence on co-location of research & industry
4. Policy implications

# Conclusions

1. Marginal cost of producing and scaling up **intangible products** changes innovation in the digital age
   i. more collaborative ii. faster
   iii. more service-based iv. with data as core input
2. **Market dynamics are affected** at social, industrial and *regional level*
3. **Distance is not "dead" -> the world is "spiky"**
4. Support for regions needs to take into account these dynamics & new ways of connecting -> **research institutions are pivotal**

# OECD-TIP Digital and Open Innovation project

**Project website:** www.innovationpolicyplatform.org/TIPdigital

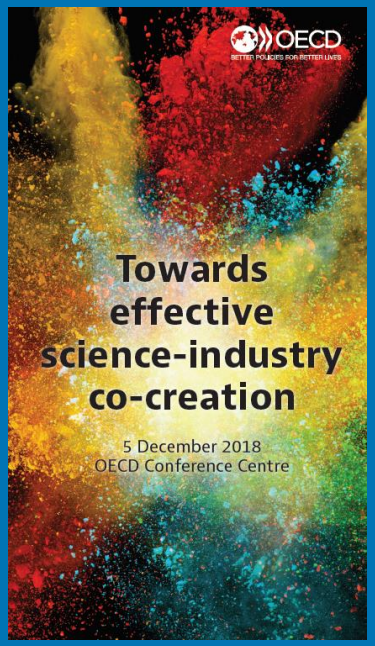
**Recent project events:**



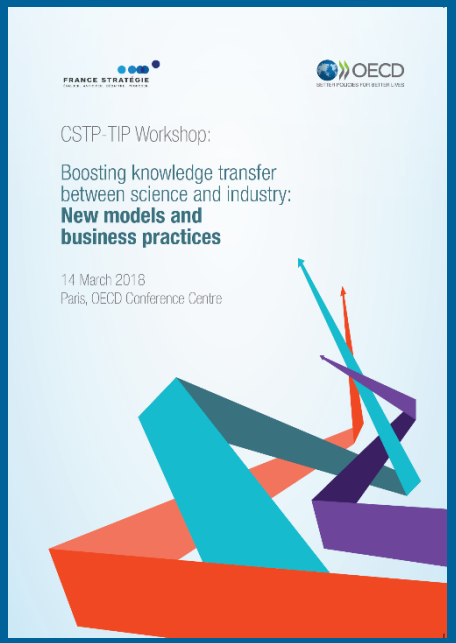

# OECD-TIP project on Assessing the impacts of knowledge transfer and policy

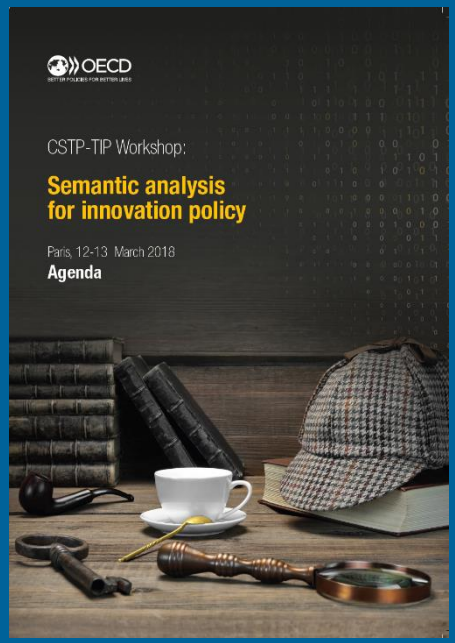
**Project website:** www.innovationpolicyplatform.org/impact

## Upcoming event:




## Recent project events:





**TIP website:** oe.cd/tip **Contact:** Caroline.Paunov@oecd.org